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ABSTRACT

One hundred twenty-eight undergraduates were randomly assigned to one of four treatment conditions formed by crossing two levels of task difficulty (computationally easy or difficult problems) with two modes of calculation (solving by hand or calculator). When solving problems by hand, there was a large increase in state anxiety between easy and difficult problems. However, level of anxiety experienced on easy problems solved by hand was not lower than the difficult problems solved with the aid of a calculator. Results of this study provide additional evidence for the benefits of using calculators, particularly as problem difficulty increases. (Author)

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Effects of Calculator Usage and Task Difficulty on State Anxiety in Solving Statistical Problems

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One hundred twenty-eight undergraduates were randomly assigned to one of four treatment conditions formed by crossing two levels of task difficulty (computationally easy or difficult problems) with two modes of calculation (solving by hand or calculator). When solving problems by hand, there was a large increase in state anxiety between easy and difficult problems. However, level of anxiety experienced on easy problems solved by hand was not lower than the difficult problems solved with the aid of a calculator. Results of this study provide additional evidence for the benefits of using calculators, particularly as problem difficulty increases.

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Objectives and Theoretical Framework

A number of studies have demonstrated the positive effects on time, accuracy and attitudes of using a calculator for solving quantitative problems. For example, superior arithmetic problem solving when using a calculator has been demonstrated using sixth graders (Hawthorne and Sullivan, 1975) and ninth graders (Cech, 1972). Studies have shown that calculators can be beneficial for college students, particularly on more difficult problems (Roberts and Glynn, 1979), and when a more sophisticated calculator is used (Roberts and Fabrey, 1978).

Based on Cattell and Scheier's (1961) factor analytic studies, Spielberger conducted a series of experiments to explore the distinction between state and trait anxiety (Spielberger, 1966). Spielberger refers to state anxiety as a reaction to a response, and this type of reaction is the typical conception of "anxiety." Trait anxiety, however, refers to individual differences in anxiety, or the latent disposition for an anxious reaction if triggered by a sufficiently stressful stimuli. Writers such as Lazarus (1974) speak of mathophobia as a specialized type of anxiety, capable of being triggered by the stressful stimuli of quantitative work. Although increased speed and accuracy are obvious benefits derived through calculator usage, the possible reduction of anxiety may prove to be the greatest benefit offered by the widespread use of calculators.

The present investigation explored differences in state anxiety experienced with or without the benefit of using a simple calculator to solve easy or difficult statistics problems.

Methods

Subjects - The subjects were 128 undergraduate volunteers drawn from an introductory statistics course at The Pennsylvania State University. Subjects were given bonus course points as an inducement to participate.

Independent Variables - The two independent variables each had two levels. The experimental design was a 2 X 2 factorial analysis of variance which utilized trait anxiety as a covariate. Trait anxiety was measured by Form X-2 of the State-Trait Anxiety Inventory (STAI, X-2)*. The first factor was calculator usage, subjects either used a paper-and-pencil method or a Texas Instruments TI-2550 calculator as an aid in statistical problem solving. The TI-2550 is a general purpose calculator including memory and square root capabilities. The second between subjects factor was level of computational difficulty of the problems, either single digit numbers (Easy) or three digit numbers with decimals (Difficult). Subjects either solved the easy problems or the more highly stressful difficult problems.

*The authors wish to thank Charles D. Spielberger for permission to administer the STAI.

Dependent Variables - The primary dependent measure was the level of state anxiety experienced, as measured by Form X-1 of the State-Trait Anxiety Inventory (STAI, X-1). Data was also collected on two performance measures, the number of minutes used in solving the ten experimental problems and the number of problems solved correctly.

Procedure - The experiment was performed in two phases. During the first phase potential subjects were asked to read about the experiment, sign a consent form and complete the trait anxiety inventory.

During the second phase, subjects were randomly assigned to one of four experimental conditions and then seated in an isolated cubicle. Subjects read an introduction to the experiment, and, for those subjects using a calculator, a description of the functions of the calculator was provided. Subjects using the paper-and-pencil method were provided with a table of squares and square roots. All subjects worked the same set of five relatively easy practice problems and then completed the ten experimental problems which differed in the two levels of computational difficulty. Subjects completed the state anxiety questionnaire which stressed identification of feelings at this moment. Subjects were free to ask questions at any time and were debriefed following the experimental session.

Results

Results regarding the two performance measures (time and accuracy) supported earlier studies. Superior performance due to the use of even a simple calculator seems rather evident.

The impact of the use of a calculator and level of computational difficulty on state anxiety during statistical problem solving were of primary interest in this study. Table 1 shows the differences found in the level of state anxiety experienced during problem solving. By far the highest anxiety was experienced by subjects solving difficult problems by hand. When differences in trait anxiety were controlled with the covariate, both the main effects (use of calculator and problem difficulty) and the interaction were significant (see Table 2).

Implications

There appears to be clear evidence that even a very basic calculator can allow students to solve statistical problems more quickly and accurately. More importantly, students work with less anxiety about the problem-solving situation, particularly as problem difficulty increases. Students solving more difficult problems experienced more stress than those solving easier problems, but the availability of a calculator can apparently help reduce the stress of difficult problem solving.

This study suggests that it may be possible to relieve anxieties related to quantitative work through use of a calculator. In addition, the effects of difficult problem solving on anxiety and performance can be counteracted somewhat through the use of a calculator. With the present widespread availability of calculators, educators should consider increasing problem difficulty, for example using more practically oriented problems, which should not significantly increase student anxiety.

Table 1

Mean and Standard Deviation of State Anxiety for Four Treatment Groups

Modality	Problem Difficulty	
	Easy	Difficult
Calculator		
Mean	35.91	37.78
S.D.	(11.21)	(10.86)
Hand		
Mean	38.19	50.22
S.D.	(11.13)	(12.88)

Table 2

Analysis of Variance Table

Source	df	MS	F
Trait Anxiety (covariate)	1	3381.6	30.2***
Calculator	1	2031.5	18.2***
Difficulty	1	991.1	8.9**
Interaction	1	451.5	4.0*
Residual	123	111.8	

*** $p < .001$, ** $p < .005$, * $p < .05$

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